ORAL PRESENTATIONS

(1) James Pahl

Louisiana Office of Coastal Protection and Restoration, LCA Science & Technology Program

Summary of Past and Future Diversion Science Board Activities

The State of Louisiana and the U.S. Army Corps of Engineers established the Louisiana Coastal Area (LCA) Ecosystem Restoration Program to reverse the degradation trend of the Louisiana coastal ecosystem. The LCA Program emphasizes the use of restoration strategies towards achieving and sustaining a coastal ecosystem that can support and protect the environment, economy, and culture of southern Louisiana.

The LCA Program recognizes the importance of integrating the best available science and technology into restoration strategies. Consequently, the Science & Technology Office was established to ensure that integration into the design, construction and operation of LCA projects. Pursuant to that goals, the S&T Program Office manages the activities of the LCA Science Board, which was specifically established to respond to the needs of the S&T Program Office and LCA Program Management Team (PMT) by (i) providing independent overall scientific and technical review of relevant plans and actions, (ii) ensuring application of rigorous scientific principles and processes to LCA Program, and (iii) offering other scientific and technical advice as requested. The composition of the Science Board allows it to provide a broad national perspective and overall scientific and technical review of LCA Program elements in support of the PMT and S&T Program Office.

River diversions have been a significant component of every comprehensive restoration plan for the State's coastal zone since at least the Coast 2050 effort (including LCA and the State Master Plan), and are an integral component of the State's overall strategy for ensuring coastal sustainability. The prominence of diversion projects in the State's project portfolio highlights the importance of responsibly defining the benefits and liabilities of constructing and operating diversions, to educate decision-makers and stakeholders of the trade-offs associated with response options and thus facilitating better informed decisions.

To better define the status of our knowledge of system responses to diversions, the LCA S&T Program has tasked the Science Board to look at discrete technical issues associated with diversions. To date the Board has conducted two focused meetings on the topics of 1) data and models of land-building in interdistributary basins, and 2) the response of coastal fisheries to diversion operation, held in cooperation with NOAA. The LCA SB is presently working on a summary report of the first topic, tentatively titled *Efficacy of River Diversions for Wetland Growth and Stabilization*, to be completed by the end of June 2011

This present meeting on the response of wetland soils and vegetation is the third technical focused meeting in this series, as illustrated by the participation of three Board members on the Technical Panel. The S&T Program and the Board are discussed several additional technical meetings, likely in conjunction with relevant federal partners and to be followed up by similar summary reports, on the topics of fisheries response (further development of the issues identified in September 2010), social and socio-economic issues, and potential for eutrophication of near-shore water bodies.

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(2) Barbara A. Kleiss

LCA Science & Technology Office, USACE, Mississippi Valley Division

An Overview of Mississippi River Diversions in South Louisiana

Much of coastal Louisiana has been formed by alternating courses of the lower Mississippi River, forming mosaics of deltas and sub-deltas under various sea level rise and continental conditions. Given this, it seems logical to seek to restore portions of the coast by augmenting the coastal areas with water and sediments from the Mississippi River. Changes in the hydrologic and sediment regimes of both the river and the receiving waters that can be anticipated as being caused by or exacerbated by diversions should be understood and acknowledged during the project planning and design process in order to assist decision makers and inform the public.

If we define the lower Mississippi River as starting at the Old River Control Structure, we presently have eight constructed diversions. Their maximum releases range from 2100 cfs (cubic feet per second) to over 1,500,000 cfs. There are proposals for constructing up to an additional twenty-five or so diversions ranging from 1,000 to 50,000 cfs. In addition, there are numerous crevasses, navigational cuts and small distributaries, especially on the eastern bank of the Mississippi River south of river mile 40, where there are no flood control levees.

Given the scope of these proposed construction activities, there are many efforts underway to better understand the nature of the lower Mississippi River and the cumulative effects of these projects both on the river and on the receiving estuaries. Some of these efforts include plans to improve the stream gage and sediment collection stations along the river, an assessment of the extent of shoaling and potential effects on the navigation system, an evaluation of suspended sediment loads in the lower river, a review of land building models and estimation constructs and the generation of a holistic hydraulic and sediment transport modeling system.

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(3) Richard C. Raynie

OCPR Louisiana Applied Coastal Engineering & Science (LACES) Division

Louisiana’s perspective on river diversions for coastal protection and restoration

There is an urgent need to restore and protect Louisiana coastal systems. Diversions of water and sediment from the Mississippi and Atchafalaya Rivers have been a part of every wetland restoration plan in Louisiana for the past 2 decades and are an important option not only for restoring and protecting, but also sustaining, these coastal systems. Since the hurricanes of 2005, numerous scientific panels have studied and commented on how to save the Louisiana coast from continued degradation, and these panels invariably stated that in order to create a sustainable coastal environment, with all of the associated nationally significant ecosystem services and economic benefits, we need to harness riverine resources and re-establish deltaic processes that have been severed by navigation and flood protection measures over the past century.

Three freshwater diversion restoration projects became operational in 1991-1992 and have been monitored and studied since that time. In addition, several sediment diversions have also been constructed and many more diversions are in various stages of planning. Based on the results of these projects, there is general agreement that while we may not have all the answers, we do have enough technical information to move forward in a deliberate and adaptive fashion to construct diversions, monitor them, and adaptively manage their operations as we learn more about the systems.

The Mississippi and Atchafalaya Rivers and associated deltas are dynamic and are changing. We cannot expect that the future will be static, but we can predict what the future landscape will look like under different scenarios. We are developing and using new predictive tools to balance the many uses of the river (navigation, industrial and municipal water supply, etc), predict the effects of changes to river management strategies, and resolve questions that remain. The future will include changes and difficult trade-offs and it is in our best interest to proactively prepare and engineer this future, rather than be reactive and unprepared for future natural disasters.

Some of the remaining questions and issues that need to be resolved include questions about the lower-river, such as sediment availability, minimum flows necessary to sustain navigation, effects of diversions on dredging needs, sustaining productive fisheries, and the response of vegetation and soils to the introduction of river water. Other issues are more wide-reaching and focus on the entire Mississippi River system, such as nutrient reduction strategies and releasing trapped sediment from behind locks and dams in the upper Mississippi River drainage basin.

While we work to resolve these issues, we need to urgently move forward with projects which will re-establish deltaic processes and look for opportunities and synergies with other projects (e.g., beneficial use of dredge material) to strategically build and sustain land. Then, utilize adaptive management to monitor the changes that occur over time, assess the benefits and impacts, and then refine, modify, and adapt the operations as needed to ensure positive changes.

We have an opportunity to learn from the lessons of the 20th century to revise river management strategies for the 21st century.

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(4) Cathy Tortorici and Buck Sutter

NOAA National Marine Fisheries Service

Gulf Coast Ecosystem Restoration Task Force: Restoration planning and implementation for the Gulf of Mexico

Background: In June, 2010, President Obama appointed Secretary of the Navy, Ray Mabus, to lead an effort to create a plan for the long-term restoration and recovery of the region beyond addressing the impacts of the Deepwater Horizon oil spill. The Plan, entitled, "*America's Gulf Coast: A Long Term Recovery Plan after the Deepwater Horizon Oil Spill*," was released in September 2010. It addressed three components of long-term recovery: environmental restoration, economic development, and public health recovery.

Task Force Structure: As a result of the Plan, a Task Force, of which NOAA is a part, was established through Executive Order on October 5, 2010, will develop a Gulf of Mexico Regional Ecosystem Restoration Strategy for the President by October, 2011. Task Force membership includes the five Gulf states and representatives from the Departments of Agriculture, Commerce, Interior, Justice, and Transportation, along with the Environmental Protection Agency, U.S. Army Civil Works/Corps of Engineers, the Office of Management and Budget, the Council on Environmental Quality, the Office of Science and Technology, and the Domestic Policy Council.

As part of the Task Force, a state and Federally staffed science work group is now established to provide guidance and advice on restoration science and research needs to support this effort. The science workgroup is conducting a number of key activities, including:

- Development and/or review of a vision and goals of a healthy Gulf of Mexico
- Development and/or review of specific and quantifiable outcomes, activities, and performance indicators
- Identifying scientific gaps
- Development and/or review of science-based criteria to develop restoration projects in support of holistic, Gulf wide restoration
- Identification of tools supporting assessment, monitoring, and adaptive management of holistic restoration efforts
- Evaluate mechanisms (existing or new) for effective integration of research/scientific assessments into adaptive management

Principles for Action: The Task Force's implementation strategy will be built on the following principles that serve as drivers for achieving the vision of resilient and healthy Gulf of Mexico ecosystem:

1. Coastal Wetland and Barrier Shoreline Habitats are Healthy and Resilient
2. Fisheries are Healthy, Diverse and Sustainable
3. Coastal Communities are Adaptive and Resilient
4. More Sustainable Storm Buffers Exist
5. Inland Habitats, Watersheds and Off-Shore Waters are Healthy and Well-Managed

Broad scale ecosystem restoration is key to the realization of these principles in the Gulf of Mexico. The Task Force Executive Order broadly defines ecosystem restoration as,

> "Ecosystem restoration" means all activities, projects, methods, and procedures appropriate to enhance the health and resilience of the Gulf Coast ecosystem, as measured in terms of the physical, biological, or chemical properties of the ecosystem, or the services it provides, and to strengthen its ability to support the diverse economies, communities, and cultures of the region. It includes activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity, and sustainability. It also includes protecting and conserving ecosystems so they can continue to reduce impacts from tropical storms and other disasters, support robust economies, and assist in mitigating and adapting to the impacts of climate change.

Freshwater diversions therefore, will be one of a number of existing restoration techniques evaluated for inclusion in the final Gulf of Mexico Restoration Ecosystem Implementation Strategy.

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(5) Denise J. Reed

Pontchartrain Institute for Environmental Science, Department of Earth & Environmental Sciences, University of New Orleans

Maintaining marsh elevation in the face of subsidence and sea-level rise: Past to present

The evolution of the Mississippi Delta plain through delta switching is well known. Land loss and land gain were both components of this evolution although land loss rates were likely much lower than rates measured during the 20th century. This implies either that the processes acting to maintain marsh elevation were more effective than at present and/or that relative sea-level rise rates were lower. This presentation will review the 'delta cycle' with respect to processes that act to maintain marsh elevation to provide a context for current decision making. In addition, the presentation will consider current marsh maintenance processes, especially surface sediment deposition, independent of river diversions. The role of weather events will be described in terms of frequency and spatial extent, with specific attention to the marsh types influenced and the potential role of this sedimentation in maintaining surface elevation in the face of current rates of relative sea-level rise. An understanding of the current process regime is essential in the consideration of the effects of river diversions on marsh maintenance and the management of resources to achieve sustainable outcomes.

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(6) Karen L. McKee

USGS National Wetlands Research Center

Biophysical controls on marsh elevation and potential impacts of global change

Management and restoration plans for large deltas and their wetland ecosystems must be based on a sound understanding of the biophysical controls on soil elevation dynamics and how these processes may be influenced by external drivers such as climate change, sea-level rise, elevated atmospheric CO_2, and large disturbances such as hurricanes. Such knowledge is especially important in geomorphic settings where human activities have drastically altered sedimentation rates and patterns. This presentation reviews how external drivers and internal biological feedbacks interact to influence the capacity of deltaic wetlands to keep pace with sea-level rise. Recent studies have shown that belowground accumulation of plant roots, rhizomes, and shoot bases contributes to vertical building of marsh and mangrove wetlands relative to sea-level rise and is sensitive to factors such as nutrients and elevated atmospheric CO_2. These studies highlight the importance of healthy, productive plant communities in promoting habitat stability of deltaic ecosystems and wetland capacity to keep pace with sea-level rise. Information about rates of biogenic inputs and how nutrients and other factors influence this process is key to understanding and predicting whether deltaic wetlands can maintain soil elevations under projected restoration scenarios. Future work will not only provide key information for modeling efforts, but will point to new strategies for improving resilience of deltaic wetlands to global change and to human modifications.

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(7) Christopher M. Swarzenski

USGS Louisiana Water Science Center

Characterization of marshes targeted by freshwater diversions

The long-term sustainability of deltaic marshes in Louisiana depends on their ability to 1) maintain surface elevation in balance with long-term water levels and 2) resist erosion by infrequent large and frequent small-scale hydraulic energy events. In the regressing portions of the delta plain, this ability largely depends on the organic matter component of the soil matrix. How do freshwater diversions, whose **primary effect is one of changing water chemistry** rather than deposition of mineral sediments, contribute to the long-term sustainability of deltaic marshes in a regressive environment?

Freshwater diversions can moderate saltwater incursions into areas dominated by healthy low-salinity marshes, preventing sulfate and chloride toxicity effects to plant communities and the organic soils they generally grow in. The nature of the salt incursions needs to be understood to effectively use diversions in this way. Another way freshwater diversions might benefit marshes is by transforming degraded brackish marsh systems to healthy resilient marshes with soil properties as described above. The processes controlling possible shifts to low-salinity plant communities capable of building organic soils, and the processes controlling the transition from a degraded soil to a healthy soil should be clearly understood before diversions can be considered for this purpose. Healthy and degrading marshes are characterized in this presentation.

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(8) John W. Day

Dept. of Oceanography and Coastal Sciences, Louisiana State University

Scales of riverine input to coastal wetlands in Louisiana: Implications for diversion management

Three case studies with varying river input are used to investigate the impact of riverine input on coastal wetlands: the Bonnet Carré Spillway, Old Oyster Bayou near the southern end of Fourleague Bay, and Breton Sound wetlands impacted by the Caernarvon diversion. The Bonnet Carré Spillway (BCS) represents one end of the range of river input to coastal wetlands. The spillway experiences infrequent (about once a decade) but large (3000 – 9000 m^3/sec) pulses of river water. There are striking differences between the spillway and adjacent LaBranche (LB) wetlands (elevation up to 2 m vs close to sea level, accretion 2.5 vs 0.4 cm/yr, and cypress growth rates twice as high in BCS vs LB). Old Oyster Bayou OB) is regularly impacted by the Atchafalaya River while Bayou Chitigue (BC) is isolated from river input. Soil strength is more than 10x higher at OB than BC as a result of frequent soil drainage that promotes consolidation and compaction. OOB floods 15% of the time vs 85% for BC. Sediment input is 2x higher at BC but elevation gain is higher at OB due to a lack of consolidation at BC. Measurements were made of above and below ground biomass and decomposition at wetlands impacted by the Caernarvon diversion. Streamside wetlands had high above- and belowground biomass and similar rates of belowground decomposition. There were no significant differences with distance from the diversion. These results suggest that the Caernarvon diversion should be operated in a pulsed manner to maximize sediment input while lowering freshwater input. Frequent wetland drainage should be allowed so that compaction and consolidation can take place. Flooding duration appears to be a major factor affecting wetland dynamics and loss.

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(9) R. Eugene Turner

Department of Oceanography and Coastal Sciences, Louisiana State University

Consequences of River Diversions to Louisiana Coastal Marshes Belowground

Most plant production by emergent coastal marshes occurs belowground. This belowground production adds to the accumulation of organic matter sustaining salt marshes as sea level rises, thus preventing excessive flooding, eventual plant death, and habitat loss. The ubiquitous nutrient enrichment of coastal marshes stimulating aboveground plant growth may result in higher rates of inorganic matter accumulation that compensates for some of the marsh flooding caused by sea level rise. But will the soil system be compromised? We conducted field experiments and observations at a combination of geographically diverse and regionally-specific sampling of above- and belowground plant biomass in western Atlantic and Gulf of Mexico marshes to understand the belowground responses of the dominant salt and fresh marsh plants to N and P additions. The results indicate that nutrient enrichment leads to lower root and rhizome biomass, belowground production, organic accumulation and soil strength. Phosphorus additions, more than nitrogen, seems to reduce root and rhizome biomass accumulation in these salt marshes. Higher soil respiration and a lower Eh are anticipated additional soil property changes, revealing a loss of belowground carbon. Further, the soil strength is reduced below the rooting zone. Examples will be discussed that demonstrate how the cumulative effects of increased nutrient loadings is to accelerate the conversion of emergent plant habitat to open water, particularly at the lower elevation range of the plant and during the occasional large storm.

Implications: Sustaining and restoring coastal emergent marshes is more likely if they receive a lower, not a higher, nutrient load. This conclusion is at odds with the rationale for river diversions and sewage treatment wetlands in unconfined natural marshes when wetland conservation or restoration is the management goal. The results are consistent with the high land loss post- Katrina/Rita in the Caernarvon flow path, but not in a reference marsh. Large river diversions into organic soils, an unproven restoration approach, may, therefore, be causing wetland loss, and not restoring them. Bringing Mississippi River water into what is basically an organic-soil appears to hasten their demise. The effect of the cumulative nutrient loading is not compensated by the sparse sediment load delivered simultaneously, or by freshening up the flow path habitats. “Do no harm” is an applicable rubic.

The increased nutrient loading from the Mississippi River watershed this century has also driven the formation of the low oxygen zone (Dead Zone) that forms off the Louisiana-Texas shelf each summer. Restoring either offshore or estuarine ecosystems necessitates, therefore, improving water quality in the watershed.

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(10) Guerry O. Holm, Jr.[1], Erik F. Peterson[2], D. Elaine Evers[3], Charles E. Sasser[3]

[1]CH2M HILL

[2] College of Architecture and Urban Studies, Virginia Tech

[3]School of the Coast and Environment, Louisiana State University

Contrasting the historical stability of wetlands exposed to Mississippi River water

The freshwater wetlands of the Mississippi R. delta plain occupy the oldest geomorphic positions of the delta and they represent an evolutionary endpoint as they transition from attached, continuous peat deposits to detached floating marsh and eventually open water. Plant health is critical to freshwater marsh stability, and chronic disturbance or stress to the plant community results in wetland fragmentation and loss. The disintegration of freshwater delta wetlands has occurred along the coast in the presence and absence of Mississippi River water influence in recent decades. In the absence of river influence, hydrologic modification and salt exposure has been implicated in wetland loss. But in the case of wetlands near river influence, nutrient enrichment/water quality has been suggested as an additional wetland stress. A theoretical cascade of nutrient enrichment events could occur simultaneously--reduced plant root production, accelerated soil decomposition, plant community shifts, and nutria population eruption/overgrazing—to produce both an organic matter deficit and reduced soil strength and eventual marsh loss. While there is scientific support for these individual responses (e.g. increased organic matter turnover rate with nitrogen exposure), demonstrating at the landscape scale the degree to which this cascade operates and is responsible for recent wetland deterioration at specific locations is uncertain. We will examine the historical landscape changes of wetlands exhibiting stable and unstable extremes, both of which receive persistent river water exposure. A summary of historical river conditions and other stresses are presented that may have contributed to stability or collapse. Before generalizations can be accepted about the consequences of nutrient loading on specific delta wetland systems, the primary constraints on their stability, such as geology and hydrology, also need full consideration.

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(11) Jenneke M. Visser[1] and Charles E. Sasser[2]

[1]University of Louisiana Lafayette

[2]Louisiana State University

The effect of nitrogen on marsh vegetation biomass and herbivores implications for freshwater diversions

The interaction between nutrients and herbivores is an important consideration in the evaluation of the effects of freshwater diversions on plant biomass. Evaluation of long-term (17 year) biomass data from fresh and saline marshes reveals that biomass is low during years with either high or low nitrogen in the surface water and higher in years of medium nitrogen in the surface waters. The low biomass at higher nitrogen conditions may be explained by the positive correlation between nitrogen in the surface water and herbivore density. These results indicate that additional primary production due to additional nutrients may result in increased secondary production and may not substantially increase organic accretion.

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(12) Mark W. Hester[1] and Kimberly J. Fisher[2]

[1]Coastal Plant Ecology Laboratory, Biology, University of Louisiana Lafayette

[2]Regulatory Branch, US ACE

Effect of salinity encroachment and nutrient loading on plant community change and sustainability of thick-mat floating marsh

There are an estimated 160,000 hectares of floating freshwater marsh (flotant) in Louisiana's deltaic plain. *Panicum hemitomon* serves as the ecological engineer of thick-mat flotant through its extensive network of roots and rhizomes, which contribute to the formation and sustainability of the highly organic and buoyant mat. Thick-mat flotant is an especially important floating marsh type since it provides many of the same ecosystem services as non-floating freshwater marshes, including habitat support for large mammals. Diversions of Mississippi River water are currently being considered as one of the most effective large-scale restoration strategies for Louisiana's deteriorated wetlands. However, the water quality of the Mississippi River has changed considerably since the agricultural revolution (early1950s), especially in terms of increased nitrate loads, which have increased two to threefold. To increase our understanding of the potential response of thick-mat flotant to future scenarios of either increased salinity levels or increased nutrient loading, we conducted a manipulative mesocosm experiment utilizing intact sods of *Panicum hemitomon* dominated thick-mat flotant. We hypothesized that thick-mat flotant may display a shift in community composition, and possibly an accompanying decrease in buoyancy, under conditions of either increased nutrient loadings or minor increases in salinity. To test these hypotheses, individual sods of thick-mat flotant were collected from the field and placed in large, 200-L mesocosm vessels, each with an independent reservoir in which nitrate and phosphate loads could be manipulated and salinity levels maintained. A completely cross-classified factorial treatment design was implemented with 2 salinity levels (0, 2.5 ppt), 2 nitrate loading rates (oligotrophic, elevated), and 2 phosphate loading rates (oligotrophic, elevated). Elevated nutrient loads were based on loadings reported from the Mississippi River diversion at Caernarvon, Louisiana. The relatively minor increase in salinity from fresh to 2.5 ppt significantly altered flotant community composition by decreasing species richness, essentially eliminating *P. hemitomon* from the community, and resulting in severely decreased sod buoyancy. Importantly, high nitrate loading (whether in the presence or absence of increased phosphate loading) also resulted in shifts in the plant community and decreased sod buoyancy. Increased phosphate loading in the absence of increased nitrate loading did not significantly alter the plant community or sod buoyancy. However, under high nitrate loading, species that are characteristic of thin-mat flotant (*Eleocharis* sp. and *Hydrocotyle* sp.) increased in relative abundance, and their prevalence was increased the most under the combination of high nitrate loading in conjunction with high phosphate loading. These findings suggest that either increased nitrate loading or a minor increase in salinity can negatively impact thick-mat flotant plant community composition and sustainability. Although data gaps still remain on some critical issues, such as the age and organic matter content of the receiving wetland (e.g., developing versus mature) and interactions with hydrology (frequency, depth, duration of flooding), it is clear that the use of large-scale river diversions will require careful planning in terms of proposed locations, wetland habitat types, and operation within basins if they are to be effectively utilized to optimize wetland benefits and sustainability.

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(13) Gregg A. Snedden and Gregory D. Steyer

USGS National Wetlands Research Center

Vegetation composition shifts in Upper Breton Sound: Possible influences of the Caernarvon Diversion, wetland hydroperiod, and hurricane disturbance

Ecologists and resource managers often conceptualize restoration measures and stressors as having immediate impacts on ecosystem structure and function, but some ecological communities may demonstrate persistence long after changes in the stressor regime have occurred. Emergent marsh vegetation in upper Breton Sound consisted of a brackish community dominated by *Spartina patens* in the early 1990s, when the Caernarvon Freshwater Diversion Structure became operational. This diversion was largely responsible for a reduction in salinities from a brackish pre-Caernarvon regime to the fresh-intermediate regime in place today. This reduction in salinity was not initially reflected in the vegetation community. Analyses of vegetation data collected at seven sites in the upper basin between 2000 and 2010 clearly indicate a shift in vegetation community composition from one exclusively dominated by S. patens to a community dominated by *Polygonum punctatum* and *Echinochloa walterii*. This community shift coincided with pronounced increases in hydroperiod that occurred in the region. These observations suggest that established vegetation communities may respond quite slowly to changes in hydrology, and that these responses may require acute disturbances that favor colonization by post-disturbance species.

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(14) Andy Nyman

School of Renewable Natural Resources, Louisiana State University

Effects of salinity and nutrients on plant growth and soil organic matter decomposition in Louisiana coastal marshes

1. In Louisiana coastal marshes, different amounts of mineral and organic matter are incorporated into accreting soils. Spatial patterns of vertical accretion demonstrate that accretion accelerates in response to relative sea-level rise up to a limit. Beyond a limit, accretion is inadequate and marshes convert to shallow open water. What limits accretion? Coastal marshes on the northern Gulf of Mexico and New England accrete via vegetative growth. Mineral sedimentation in these marshes increases soil bulk density rather than surface elevation. Bulk density is positively related to plant biomass; thus, mineral sedimentation probably is indirectly important to accretion via vegetative growth. Accretion via vegetative growth depends upon the balance between plant growth and soil organic matter decomposition.

2. Diversions might alter plant growth by adding nutrients (smaller area) and/or reducing salinity (larger area). The most common plant in coastal Louisiana, <u>Spartina patens</u>, cannot uptake nutrients when salinity is high. Discussion of this situation is complicated because some authors refer to this situation as nutrient limitation but others refer to this as salinity limitation. The same is true for *S. alterniflora* and discussion is similarly complicated. At low salinity, *S. patens* generally is nutrient-limited. River diversions that introduce nutrients into low-salinity marshes can increase plant growth because those marshes generally are nutrient limited. River

diversions that reduce salinity in high-salinity marshes can increase plant growth without adding nutrients because reduced salinity allows plants to uptake nutrients unavailable at high salinity.

3. Diversions might alter soil organic matter decomposition by adding nutrients (smaller area) and reducing salinity (larger area). Nutrients might alter decomposition by adding to surface water nutrients that limit growth of decomposers (short term) and/or by increasing the amount of nutrients incorporated as plants grow (long term). Marsh soils responded to nutrient additions with levels used in agriculture being required to cause statistically significant effects. Decomposition is fastest in fresh marshes and slowest in brackish marshes because of differences in the quality of soil organic matter rather than differences in water salinity. *Spartina patens* soil far from the Caernarvon diversion structure decomposed at the same rate as *S. patens* soil near the structure and was unaffected by salinity and nutrient additions.

4. Soil strength varies with live roots rather than with mineral sediments. Fresh marsh soils are weaker than saline marsh soils because they have fewer live roots. This discussion is complicated by measurements based on percentages rather than density. For instance, an average fresh marsh soils is 35% organic matter but has one third the organic matter (0.02 g/cm^{-3}) that an average saline soil has (0.06 g/cm^{-3}) even though the saline soil is only 25% organic matter because the bulk density of the fresh marsh (0.07 $g\ cm^{-3}$) is much less than the bulk density of the saline marsh (0.24 $g\ cm^{-3}$). Weaker soils in fresh marshes coincide with perennial plant species that convert open water to emergent vegetation via vegetative spread. Such spread is impossible in saline marshes, which are more resistant to erosion.

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(15) Christopher Schulz

Southeastern Louisiana University

Alkalinity and nutrient impacts on a freshwater marsh: theory, experiments and observations

Several freshwater diversion projects are online and many more are proposed, drastically altering the hydrology and nutrient flux in Louisiana wetlands. The intention of these massive projects is to prevent saltwater intrusion and provide sediments and nutrients to combat coastal erosion and subsidence. A proposed mechanism that such diversions decrease land loss is through the increase in vegetative biomass accumulation, leading to net gains in organic sediments. Although freshwater and nutrients can enhance primary production, it is unclear what impact these waters will have on existing sediment organic reservoirs. A growing number of studies suggest that nutrient additions to wetland systems can lead to enhanced soil decomposition; thus, freshwater diversion projects may actually enhance wetland deterioration. A wetland restoration project delivering five million gallons per day of treated domestic effluent to the Joyce Wildlife Management Area (JWMA) marsh began in 2006. The treated effluent is similar to Mississippi River water with respect to alkalinity, but contains elevated reactive nitrogen concentrations. Sediment carbon and nitrogen content was monitored pre and post restoration project commencement and decreased significantly over a two year period from 2006 to 2008. The change in water chemistry (alkalinity/pH and reactive nitrogen) was expected to have an impact on microbial activities in these sediments. The microbial community composition of methanogens and archaeal ammonia oxidizers (as monitored by mcrA and amoA gene clone libraries, respectively) also shifted during this time period. Microcosm experiments using relatively un-impacted JWMA sediments with bicarbonate additions showed increased methane production (i.e. enhanced organic matter / plant matter decomposition) corresponding to increasing alkalinity. Pore-water samples also demonstrated a similar trend with increased dissolved methane corresponding to increasing alkalinity and nutrients (ammonia and phosphate). The effects observed in experiments conducted in this study are not readily incorporated into generalized models due to lack of information, demonstrating the need for more focused research.

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(16) Sean Graham and Irving A. Mendelssohn (Presenter)

Department of Oceanography and Coastal Sciences, Louisiana State University

Does nutrient enrichment affect surface elevation change in a low salinity coastal marsh?

Nutrient inputs into rivers, estuaries and coastal waters have increased in recent decades with a concomitant increase in concern over their impacts to wetland structure and function. Of particular importance is the effect that nutrient enrichment may have on the capacity of coastal wetlands to build vertically as sea level rises, which is the key process that controls their long-term sustainability. Although the capacity for marsh vertical expansion can be dramatically affected by nutrient enrichment, complex interactions between a suite of physical, chemical and biotic factors, and the paucity of direct experimental tests of the nutrient enrichment-elevation change relationship make prediction difficult. Field evaluations in a variety of wetland types are needed to generate a comprehensive picture that can be used by natural resource agencies.

In this study, we examined the effects of 11 years of biannually applied nutrient enrichment on surface elevation change and the primary processes (belowground productivity, organic matter decomposition, surface accretion) that determine surface elevation of an oligohaline coastal wetland in Louisiana. Experimental plots (2 m x 2 m) were fertilized with three levels of combined nitrogen-phosphorus-potassium fertilizer (control: no enrichment; low enrichment: 200 kg N ha^{-1} y^{-1}, 66 kg P ha^{-1} y^{-1} and 66 kg K ha^{-1} y^{-1}; high enrichment: 6-times the levels of the low enrichment). After 6 years of fertilization, surface-elevation-tables (SETs), feldspar marker horizons, belowground in-growth bags, and belowground litter bags were installed in each plot to determine the effects of nutrient enrichment on marsh elevation change, surface accretion, belowground productivity and organic matter decomposition, respectively. Surface elevation change measured over a 5-year period, and after 11-years of nutrient enrichment, was not significantly affected by nutrient application. The absence of a nutrient enrichment effect on marsh elevation change may result from counterbalancing effects on surface accretion, belowground production, shallow subsidence and organic matter decomposition.

POSTER PRESENTATIONS

(1) R. D. DeLaune, A. Jugsujinda, and G. W. Peterson

Department of Oceanography and Coastal Sciences, School of the Coast and Environment, Louisiana State University

Impact of Mississippi River freshwater diversion on coastal marsh stability

To counteract extensive wetland diversion projects have been implemented to introduce freshwater and sediment from the Mississippi River into Louisiana coastal wetlands. The impact of Mississippi River freshwater diversion on enhancing vertical marsh accretion (mineral and organic matter accumulation) was examined in Breton Sound estuary, a coastal wetland experiencing marsh deterioration as result of subsidence and salt water intrusion. Using ^{137}Cs dating and artificial marker horizons, increases in the rate of vertical marsh accretion were measured at marsh sites along a spatial gradient which has been receiving diverted water from the Mississippi River (Caernarvon diversion) since 1991. Vertical accretion and accumulation of mineral sediment organic matter and nutrients in the marsh soil profile, increased at marsh sites receiving freshwater and sediment input. Iron and manganese content of the marsh surface sediment were shown to be an excellent signature of riverine sediment deposition. Soil extractable phosphorus was higher and extractable sodium was lower at sites nearest freshwater and sediment input. Results demonstrated that freshwater diversion through sediment input and lowering of salinity will enhance marsh accretion and stability, slowing or reversing the rate of wetland loss.

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(2) Beth A. Middleton[1] and Brian J. Roberts[2]

[1]U.S. Geological Survey, National Wetlands Research Center, Lafayette, Louisiana

[2]Louisiana University Marine Consortium (LUMCON). Chauvin, Louisiana

Impact of hydrologic remediation efforts after the Deepwater Horizon oil spill incident on elevation maintenance and ecosystem processes in Gulf Coast baldcypress swamps.

One of the proactive actions taken in Louisiana to prevent the oiling of coastal environments following the Deepwater Horizon oil spill incident was to open most of the Mississippi River freshwater diversions to full or close to full capacity in an attempt to push oil away from coastal wetlands in Louisiana south of New Orleans. In total, these diversions rerouted ~35000 cfs (~1000 $m^3 s^{-1}$) of Mississippi River water out through Louisiana's sensitive coastal wetlands. One of these diversions, Davis Pond (10,650 cfs or 302 $m^3 s^{-1}$), increased the freshwater flow through our long-term study sites of baldcypress swamp function in Jean Lafitte National Historic Park. As part of a NSF RAPID award project, we are studying the impacts of this hydrological remediation on ecosystem processes related to elevation maintenance including production, decomposition, tree growth, and regeneration and soil respiration and greenhouse gas fluxes. We are studying ecosystem processes seasonally in three coastal baldcypress swamps across the Gulf Coast including a hydrologic remediation site (Jean Lafitte National Historical Park in LA) and two control sites (Big Thicket National Preserve in TX and St. Marks National Wildlife Refuge in FL). We are also comparing results at Jean Lafitte during the 2010/2011 period with those from the five years prior to the extended opening of the Davis Pond diversion in spring and summer 2010. This research is on-going but initial findings suggest that the opening of the diversion to remediate the oil spill had impacts on the hydrology of Jean Lafitte which resulted in baldcypress trees growing twice as much in 2010 as in 2009 (mean growth increment = 20 versus 10 mm, respectively).

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(3) Andrew Tweel and R. Eugene Turner

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Watershed land use and river engineering drive wetland formation and loss in the Mississippi River birdfoot delta

The Mississippi River Birdfoot Delta (MRBD) in the 1930s is often used as an archetype for restoration of this deteriorating coast. We address here whether the enlarged 1930s land area and processes that built it are an appropriate baseline for restoration. The Mississippi River Basin was developed for agriculture at an unprecedented scale and intensity within the last 200 years. These changes favored erosion and sediment transport, which were subsequently reduced by soil conservation practices and the trapping of sediment behind large reservoirs. The MRBD expanded rapidly in the late 19th century, but many of the newly formed wetlands reverted to open water within a few decades. We report an increase in mean suspended sediment concentrations in the Mississippi River below New Orleans, from an estimated 350 mg/L at the end of the 18th century to a maximum of 675 mg/L in the late 19th century, and then a sharp reduction and relative stabilization around 157 mg/L after 1962. Changes in land area of the MRBD over the past two centuries reflect these changes in sediment supply during periods of increasing, decreasing, and stable sediment loading, and are distinct from the rest of the deltaic plain. Land change processes in the MRBD should therefore be considered separately from other Louisiana wetlands. Additionally, future variation in sediment supply would likely change land area of the MRBD.

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(4) Christine M. VanZomeren, John R. White, and Ronald D. DeLaune

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Fate of diverted Mississippi River nitrate in a vegetated brackish coastal marsh

The Caernarvon Diversion meters Mississippi River water into the brackish and salt marshes of Breton Sound during spring flooding. Elevated levels of nitrate delivered through the Caernarvon Diversion have recently sparked concerns that nitrate loading is affecting plant resilience, in particular, potentially affecting belowground biomass. This concern resulted from observation that the fresh and brackish Breton Sound marshes suffered extensive damage from Hurricane Katrina. Our hypothesis is that the nitrate from the Mississippi River is primarily removed by denitrification. To test this hypothesis, 12 plant-sediment cores were collected from a brackish marsh located proximal to Delacroix, Louisiana. Six received dionized water (control), while another six (treatment) received 2 mg/L of ^{15}N-labeled potassium nitrate twice a week for three months. A set of three control and treatment cores were destructively sampled after three months and analyzed for ^{15}N in the aboveground and belowground biomass as well as denitrifying enzyme activity. The remaining three treatment cores received 20 mg/L of ^{15}N-labeled potassium nitrate twice a week for one month and the fate of the ^{15}N- nitrate was used to distinguish different removal pathways, including denitrification, surface algae uptake, incorporation into aboveground biomass, and incorporation into belowground biomass. Preliminary results show that just 24 hours after the addition of 2 mg/L nitrate, levels were below detection, which suggests denitrification or surface algae are the major removal pathways. Results of the partitioning of ^{15}N by soil microbes, surface algae, aboveground biomass, and belowground biomass will be presented.

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(5) Hang Yin and Guoping Zhang

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Development of a field vane to characterize the shear strength of wetland surface sediment

In-situ characterization of the critical shear stress of top surficial cohesive sediment is of vital importance for the assessment of erosion and failure of wetlands subjected to wave and surge hydrodynamics and wave-sediment interactions. This critical stress is closely related to the undrained shear strength of the soils, which is conventionally obtained by using either a field shear vane (FSV) tester in-situ or other erosion apparatuses in the laboratory. However, neither of the methods is adequate for assessing the erosional resistance of surficial soft soils (which has very low strength in the very top layer) on tidal flats and wetlands. A new Louisiana scour vane (LSV) for in-situ measuring the undrained shear strength of surficial soft sediment has been designed and fabricated. This new vane consists of multiple blades of only 1 cm in height, but with significantly increased diameter compared with the traditional field shear vane. Laboratory testing was conducted using reconstituted clays to calibrate the LSV and examine its expected functionality. This new portable and easy-to-operate device will be a suitable tool complementary to the traditional FSV for coastal sediment characterization.